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Data processing system and method and pocket-size hermetically sealed electronic device.

Abstract:

A system in accordance with the present invention is arranged to carry out data processings by selecting and combining basic functions provided in a pocket-size hermetically sealed electronic device by operating from an external equipment. The pocket-size hermetically sealed electronic device includes a mask ROM (36) which is memorizing programs for realizing a plurality of kinds of basic functions, a RAM (38) which memorizes various kinds of data that accompany the basic functions, a connection section (40) which receives a command that includes at least function codes for selecting programs of the plurality of kinds of basic functions based on a command from the connection section, and carries out the functions in accordance with the programs selected.

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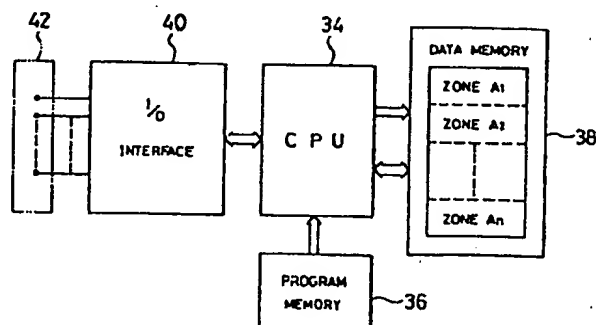
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54 Data processing system and method and pocket-size hermetically sealed electronic device.

57 A system in accordance with the present invention is arranged to carry out data processings by selecting and combining basic functions provided in a pocket-size hermetically sealed electronic device by operating from an external equipment. The pocket-size hermetically sealed electronic device includes a mask ROM (36) which is memorizing programs for realizing a plurality of kinds of basic functions,

a RAM (38) which memorizes various kinds of data that accompany the basic functions, a connection section (40) which receives a command that includes at least function codes for selecting programs of the plurality of kinds of basic functions based on a command from the connection section, and carries out the functions in accordance with the programs selected.

FIG. 2



EP 0 190 733 A2

DATA PROCESSING SYSTEM AND METHOD AND
POCKET-SIZE HERMETICALLY SEALED ELECTRONIC DEVICE

1 BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a system which carries out
5 data processing by means of a pocket-size hermetically sealed
electronic device that has an electronic device sealed in its
inside, and more particularly to a pocket-size hermetically
sealed electronic device which can be adapted for a wide variety
of services with a single unit of the device.

10

Description of the Prior Art

In recent years, development has been under way for systems
such as home banking system, farm banking system, and home
shopping system that can make use of the communication systems to
15 the most advantageous degree. Along with it, development of the
so-called IC card has also been advanced.

An IC card is a pocket-size hermetically sealed electronic
device which has an electronic device with data processing
capability sealed inside of the card in such a way as to make it
20 impossible to read out those data that require privacy
protection. The IC card is being utilized in the above systems
for such purposes as security assurance and memory of necessary
information of the data on the network, and its application to a
wide variety of uses is being anticipated. Further, it is
25 conceivable to use it in the field of financial services for
storage of financial transaction information and
encryption/decryption. further, its use as a key to scrambling
and for storage of viewing/listening information for the pay
television has been proposed by CII Honeywell Bull, Inc.

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Moreover, it may be possible to be applied to the medical field for storage of medical information for the patients. As described in the above, the IC card is anticipated to be utilized in the future for all sorts of services that require data storage and data processing.

Now, in using IC card for various kinds of services, the form of the data to be stored and the type of data processing required are different for each service, so that service provider has to provide the user with an IC card which is different for different service. For this reason, it is conceivable to seal to the inside of the card different electronic device that is suitable for separate purposes, and manufacture and provide an IC card corresponding to each purpose of use. However, such an arrangement is undesirable since it leads to a rise in the cost of IC card. Then, one may wish to give a common structure to the hardware and cope with the variety of services by varying the software for the electronic device that is sealed in the inside of the card. In this case, it becomes necessary to provide a program memory in the inside of the card.

However, when a programmable ROM (PROM) is to be used as the program memory, writing of the program takes a long time such that for one like IC card which is to be provided to a large number of users there was a problem that a rise in the production cost was inevitable due to low mass productivity. further, for a fixed single program, it is possible to provide a card at low cost through mass production by using mask ROM for the program memory. However, in such a case it becomes impossible to provide a variety of softwares as mentioned in the above.

In the above mannewr, in spite of the anticipation that the existing pocket-size hermetically sealed electronic device will be utilized for a variety of purposes, there was a problem that it was difficult to provide at low cost a pocket-size hermiatically sealed electronic device that is applicable to a variety of services.

1 SUMMARY OF THE INVENTION

An object of the present invention is to provide a pocket-size hermetically sealed electronic device which enables
5 one to receive a wide variety of services at low cost.

Another object of the present invention is to provide a pocket-size hermetically sealed electronic device which is adapted for a wide variety of services by selecting and combining via an external equipment the basic functions provided to carry
10 out data processing.

One of the features due to the present invention is that the pocket-size hermetically sealed electronic device includes a first memory section which memorizes the program for realizing a plurality of kinds of basic functions, a second memory section
15 which memorizes various kinds of data that accompany the basic functions, a connection section which receives a command that contains at least a function command for selecting, by means of an external equipment, the plurality of kinds of basic function programs, and a control section which selects the basic function
20 programs by the command from the connection section and executes the basic functions in accordance with the programs selected.

These and other objects, features and advantages of the present invention will be more apparent from the following description of the preferred embodiments, taken in conjunction
25 with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram for illustrating the function of
30 an IC card embodying the present invention;

Fig.2 is a block diagram which shows the concrete construction of the IC card shown in Fig. 1;

Fig.3 is a perspective view of the IC card shown in Figs. 1 and 2;

35 Fig.4 is a perspective view of a data processing system which uses the IC card shown in Figs.1 to 3;

1 Fig.5 is a compositional block diagram for the system shown
in Fig.4;

 Fig.6 is a compositional block diagram for the card
reader/writer in Fig.5;

5 Fig.7 is a flow chart for illustrating the operation of the
terminal of the system shown in Fig.4;

 Fig.8 is a flow chart for illustrating the operation of the
card reader/writer of the system shown in Fig.4;

10 Fig.9 illustrates simplified diagrams that show the data
format for the data to be sent from the card reader/writer to the
IC card shown in Fig.4;

 Fig.10 is a flow chart for illustrating the operation of the
IC card of the system shown in Fig.4;

15 Fig.11 is a flow chart for illustrating the sequence when
the system shown in Fig.4 is applied to the credit card system;
and

 Fig.12 is a flow chart for illustrating the sequence when
the system shown in Fig.4 is applied to the transfer system
through bank.

20

DESCRIPTION OF THE PREFERRED EMBODIMENTS

 Referring to Figs.4 and 5, there is shown an IC card system
10 embodying the present invention in which the system 10 is
25 constructed so as to have an IC card 12 connectable to a terminal
16 via a card reader/writer 14, and a keyboard 18, a CRT display
20, a printer 22, and a floppy disk 24 connected to the terminal
16.

 The IC card 12 which is kept by the user is for carrying out
30 such operations as the referencing of the key data that is known
to the user alone and the storing of necessary data in, for
instance, purchasing a merchandise. As the diagram for its
functions shown in Fig.1 indicates, the card 12 is composed of
the parts for executing basic functions, such as an R/W section
35 26, an encryption/decryption section 28, and a password

1 setting/password collation section 30, and a supervisor 32 which
supervises these basic functions. The R/W section 26 has a
function for reading the data from the data memory in the IC card
12 or for writing a data in the data memory. The
5 encryption/decryption section 28 is for carrying out the
encryption for the data to be communicated in order to prevent
leakage or falsification in such a case as transmitting a data
from the terminal 16 to another terminal, or for carrying out the
decryption of the encrypted data. The data processing there, is
10 carried out in accordance with an encryption algorithm which has
a sufficiently high encryption capability such as the data
encryption standard (DES). The password setting/password
collation section 30 is the section for memorizing the passnumber
(key data) set up by the user, and gives a permission for the
15 subsequent processing by carrying out the collation of the key
data that is input after setting of the password. Further, the
supervisor 32 interprets the function code or the function code
supplemented by a code that is sent from the card reader/writer,
and causes the selection and execution of the required functions
20 from among the basic functions.

In order to accomplish these functions, the IC card is
composed of, as shown by Fig.2, a CPU 34, a program memory 36, a
data memory 38, an I/O interface 40, and a contact section 42.
The program memory 36 which consists of a mask ROM is for
25 memorizing the programs of the CPU 34 that are equipped with
subroutines in order to realize the various basic functions. The
data memory 38 comprises a PROM and is divided into a plurality
of zones A_1, A_2, \dots, A_n with various kinds of access conditions
assigned to separate zones, such as a zone from which read alone
30 of the data is possible using an external equipment, a zone for
which write alone is possible, a zone for which both of read and
write are possible, a zone for which both of read and write are
not possible, and a zone for which read and write are possible
only after collating of the password is completed. These
35 circuits are integrated in the form of an LSI 41 which is sealed

1 hermetically in the card 12. It is arranged to be connectable to
an external equipment only through the contact section 42. The
contact section 42 has a total of eight terminals 46 such as
those for power source, for inputting clock signals, for reset,
5 and for inputting and outputting of data.

The card reader/writer 14 transfer function code data
between the IC card 12 and the terminal 16. It possesses a
function to decompose a macro instruction received from the
terminal 16 into commands for IC card, and supplies the commands
10 to the IC card 12 in succession. More specifically, the card
reader/writer 14 includes, as shown by Figs. 5 and 6, a
transportation mechanism 48 which transports the IC card 12 that
is inserted to the card insertion port 14a to a prescribed
position, an IC card contact section 50 which makes an electrical
15 contact with the contact section 42 of the IC card 12 that is set
at the prescribed position, a control circuit 52 which controls
the device as a whole, and an I/O interface 54 which transfers
function code or data between the terminal 16.

The terminal 16 is composed of a CPU 16a and a memory 16b as
20 shown in Fig. 5, and in response to the user's demand which is
input via the keyboard 18 determines selection and combination of
function codes to be given to the card reader/writer 14 by
reading the required data processing programs that are memorized
in the memory 16b or the floppy disk unit 24. The user receives
25 the message from the terminal 16 via the CRT display 20 or the
printer 22.

Next, the operation of the system in accordance with the
embodiment constructed as in the above will be described.

As shown by Fig. 7, in a stationary state as represented by
30 step 100 the terminal 16 is in the state which is waiting for a
command from the user. As a command from the user is input, the
terminal 16 analyzes the command (step 102) and determines the
selection of necessary functions and their sequence (step 104).
When the sequence is determined the terminal 16 outputs necessary
35 command (function code) to the card reader/writer 14 (step 106).

1 Then, the terminal 16 will remain in the state of waiting until
it receives from the card reader/writer 14 a response that
indicates the completion of the processing required by the
command (step 108). Upon receipt of a response, it judges
5 whether it is a final response. If it is not a final response,
it sends out again a command to the card reader/writer 14 in
accordance with the sequence, and if it is a final response, it
returns to the state of waiting for a command from the user (step
110).

10 In step 120, when the card reader/writer 14 is in a
stationary state, it is in the state of waiting for a command
from the terminal as shown by Fig. 8. When a command is input,
it judges whether the IC card is in execution (step 122), and if
it is found to be executing, it goes back again to the state of
15 waiting for a command after outputting a response which indicates
that it is a multiple command error to the terminal 16 (step
124). If the IC card is found to be not in execution, it judges
the command from the terminal 16 to determine a set of command
sequence to be given to the IC card 12 (step 126). Following
20 that, it outputs the first command to the IC card 12 (step 128).
Then, it goes to the state of waiting for a response from the IC
card 12 (step 130). When a response from the IC card 12 is
received, it judges whether there still remains some commands to
be given to the IC card (step 132), and if it is found that there
25 are some, it returns to step 128 to repeat outputting of the
command. Otherwise, it outputs a response to the terminal 16
(step 134).

The command to be output from the card reader/writer 14 to
the IC card 12 has the format with prescribed bit length as
30 indicated in Fig. 9, with a form which contains a function code
alone as shown by Fig. 9a or a form which contains a function
code augmented by a data as shown by Fig. 9b.

In its stationary state, the IC card 12 is in the state of
waiting for a command from the card reader/writer 14 as shown by
35 Fig. 10 (step 140). When a command is input, it executes the

1 basic functions in accordance with the command (142) and outputs
the response to the card reader/writer 14 (step 144). Then, it
goes back to its original state of waiting.

5 The response in this case is supplemented by the command
that was input originally, to provide for a protective measure
for the case where the sequence between the card reader/writer 14
is disturbed.

10 It should be noted as shown in the above embodiment that it
is convenient to render the command system to be successively
more macro as one goes upstream along IC card 12 → card
reader/writer 14 → terminal 16. With such an arrangement the
preparation of application programs in the upstream will become
very easy.

15 Next, a concrete examples of operation of the system will be
described.

Figure 11 shows an example of credit card system. It is
assumed here that the sequence for the credit card system for the
terminal 16 has already been determined. The user first inserts
his IC card 12 into the card reader/writer 14. The card
20 reader/writer 14 outputs a signal that informs that an IC card 12
is inserted, to the terminal 16. Based on this, the terminal 16
urges the user to input his passnumber. When the user inputs the
passnumber the terminal 16 outputs the passnumber and the
password collation instruction to the card reader/writer 14. The
25 card reader/writer 14 outputs the passnumber and the password
collation instruction to the IC card 12. The IC card 12 executes
the password setting/password collation function to compare and
refer the input passnumber with the passnumber memorized in its
inside. When the result of the collation is affirmative, the IC
30 card 12 outputs the response to the card reader/writer 14. The
card reader/writer gives a permission to input, to the terminal
16. Based on this, the terminal urges the user to input the sum
of purchase of merchandises. When the user inputs the sum of the
purchase, the terminal 16 requests a list of past purchases from
35 the card reader/writer 14. This request command is given in

1 the form of a macro instruction, and the card reader/writer 14
outputs a read command to the IC card based on it. In response
to this command the IC card 12 executes the R/W function to
outputs the data on the previous purchases that is memorized in
5 its inside. The read command will remain in effect until the
final response is received from the IC card 12, and the purchase
list read during that time is held in the card reader/writer 14.
In this case, in order to avoid inputting of a plurality of
commands in the inside of the IC card 12, care is to be taken
10 that a next command is output after a response is returned. When
the final response from the IC card 12 is received, the card
reader/writer 14 outputs the entirety of the purchase list to the
terminal 16. The terminal 16 computes the balance to be
applicable to the purchase for the IC card from the list, and
15 outputs a write command for purchase sum to the card
reader/writer 14 only when the purchase sum is less than the
balance. This command, too, is given as a macro instruction, and
the card reader/writer 14 outputs repeatedly the write command of
data, to the IC card 12. The reason for repeating the writing of
20 data is that a single write is not sufficient to write the
entirety of the data. The IC card 12 executes the R/W function
in accordance with the command, and makes entry of the new
purchase sum in the purchase list of merchandises. When the card
reader/writer 14 received the final response, the completion of
25 inputting is informed to the terminal 16. The terminal 16
displays the balance on the CRT display 20, and outputs a message
that indicates the end of the processing, completing the purchase
of a merchandise by means of the credit card system.

Next, an example of application of the IC card to the
30 transfer system through bank will be described by referring to
Fig. 12.

It will be assumed that the terminal 16 has already
determined the sequence for the transfer system through bank.
Form insertion of the credit card 12, through password collation,
35 and up to input permission by the card reader/writer 14 are

1 carried out based on the procedure similar to the credit card
system described in the above. Then, the terminal 16 urges the
user to input necessary transfer data such as the bank account
number of the payee, the bank account number of the payer, and
5 the sum of transfer. When the user inputs the transfer data, the
terminal 16 outputs an instruction for encrypting the transfer
data to the card reader/writer 14. This instruction is given in
the form of a macro instruction, and based on this, the card
reader/writer 14 outputs to the IC card 12 an encrypted command
10 supplemented by the transfer data. The IC card 12 executes the
encryption/decryption function, and outputs an encrypted data to
the card reader/writer 14. The card reader/writer 14 stores the
encrypted data in its inside until completion of the encryption
of the transfer data. After the encryption of the transfer data,
15 the card reader/writer 14 outputs the encrypted data to the
terminal 16 upon receipt of the final encrypted data. The
terminal 16 transmits the encrypted data to the terminal for the
other party (bank) via a circuit. In response to this, the
terminal of the other party transmits a signal which acknowledges
20 the receipt of the data, where the signal transmitted is an
encrypted data too. When this data is received the terminal 16
outputs a decryption instruction along with the received data to
the card reader/writer 14. This instruction is also a macro
instruction so that the card reader/writer 14 outputs
25 continuously the decryption instruction, to the IC card 12.
Based on the instruction the IC card 12 executes the
encryption/decryption function in its inside, and outputs the
decrypted data obtained to the card reader/writer 14. Upon
receipt of the final decrypted data, the card reader/writer 14
30 outputs the entirety of the decrypted data to the terminal 16.
Then, in order to keep a documentary evidence in the inside of
the IC card 12, the terminal 16 outputs the transfer data and the
received data along with a write command, to the card
reader/writer 14. The command is also a macro command, and the
35 card reader/writer 14 outputs continuously the write command to
the IC card 12. The IC card 12 executes the R/W function in its

1 inside and stores the above data in its inside. Upon receipt of
the final response from the IC card 12, the card reader/writer 14
outputs a signal that indicates the completion of inputting to
the terminal 16. The terminal 16 outputs the message that
5 indicates the completion of transfer on the CRT display 20. With
this, the transfer operation by means of the transfer system
through bank is completed.

In this manner, according to the present embodiment the
software that determines the function selection and the
10 processing sequence in the inside of the IC card 12, through the
operation on the terminal 16, can be constructed at will by the
provider of the service so that it is possible to meet a wide
variety of data processing requirements. This becomes possible
due to the circumstance that a plurality of basic functions are
15 given to the IC card 12 and that an arrangement is made to permit
a selective execution of these basic functions. These basic
functions are not limited to those described in the foregoing so
that the utility of the present invention can be increased
greatly by arranging the functions to be applicable to all sorts
20 of services and be of general use and basic character.

It is to be noted that although the IC card is described in
conjunction with the pocket-size hermetically sealed electronic
device, the present invention is not limited to a card-like
structure and may be applied to structures of block-like or
25 pencil-like. Moreover, the hardware construction of the
electronic device will also permit various modifications within
the scope which does not deviate from the main contents of the
invention.

30

35

1 CLAIMS

1. A system which carries out data processing, comprising:

5 (a) a pocket-size hermetically sealed electronic device, comprising;

a first memory section which has memorized programs for accomplishing a plurality kinds of basic functions,

10 a second memory section for memorizing various kinds of data used for the basic functions,

a connection section for supplying a command which includes at least function codes for selecting programs of the plurality kinds of basic functions, and

15 a control section for selecting the programs of basic functions by the command from the connection section to execute the basic functions in accordance with the program selected; and

20 (b) an external equipment for supplying to the connection section the command with function codes that select the programs of the plurality kinds of basic functions through contact with the connection section, and for receiving from the connection section a response signal for the basic function executed.

25 2. A system as claimed in claim 1, wherein the plurality of kinds of the basic functions include a read/writer function of the data from the second memory section, a encryption/ decryption function for preventing leakage and falsification of the communication data, and a password setting/password collation function.

30 3. A system as claimed in Claim 1, wherein the pocket-size hermetically sealed electronic device comprises an IC card formed in the card-like structure.

35 4. A system as claimed in Claim 1, wherein the first memory section comprises a mask ROM.

1 5. A system as claimed in Claim 1, wherein the second memory
section comprises a PROM, and in which the control section
comprises a CPU.

5 6. A system as claimed in Claim 3, wherein said external
equipment comprises a keyboard, a memory unit, an IC card
reader/writer, and a CPU which reads the data processing programs
memorized in the memory unit, in response to the command which is
10 inputted via the keyboard, to select and combine the function
codes to supply the result to the IC card reader/writer, and also
executes prescribed processings by receiving a response signal of
the IC card from the IC card reader/writer.

15 7. A system as claimed in Claim 6, wherein the IC card reader/
writer comprises a transportation mechanism for transporting the
IC card inserted to a insertion port to a prescribed position, an
IC card contact section which is to be brought to an electrical
connection with the connection section of the IC card that is set
at the prescribed position, an I/O interface for carrying out
20 transfer of command from/to the CPU of said external equipment,
and a control circuit for controlling the transportation
mechanism, and the I/O interface.

25 8. A system as claimed in Claim 1, wherein the command
supplied by said external equipment comprises a function code and
a data.

30 9. A system as claimed in Claim 1, wherein said second memory
section of the pocket-size hermetically sealed electronic device
is divided into a plurality of zones assigned separately with
different access conditions.

10. A system as claimed in Claim 2, wherein said second memory
section of the pocket-size hermetically sealed electronic device
35 is divided into a zone from which read alone is

1 possible, a zone for which write alone is possible, a zone for
which both of read and write are possible, a zone for which both
of read and write are not possible, and a zone for which read and
writer are possible only after completion of the password
5 collation, with respect to the external equipment.

11. In a system which carries out data processing by means of a
pocket-size hermetically sealed electronic device in which an
electronic device with data processing function is sealed a data
10 processing method, comprising the steps of:

(a) storing programs for accomplishing a plurality of kinds
of basic functions in the pocket-size hermetically sealed
electronic device;

(b) supplying a command, which includes at least function
15 codes that select programs the plurality of kinds of basic
functions, to the pocket-size hermetically sealed electronic
device;

(c) selecting programs for basic functions based on the
command from the connecting section; and executing the basic
20 functions in accordance with the programs selected.

12. A data processing method as claimed in Claim 11, wherein
the plurality kinds of basic functions includes a read/writer
function of data from the secon memory section, an
25 encryption/decryption function for preventing leakage and
falsification of communication data, and password setting/
password collation function.

13. In a system which carries out data processing a pocket-size
30 hermetically sealed electronic device, comprising:

(a) a first memory section which has memorized programs for
accomplishing a plurality kinds of basic functions;

(b) a second memory section for memorizing various kinds of
data used for the basic functions;

1 (c) a connection section for receiving a command, which
includes at least function codes for selecting programs of the
plurality kinds of basic functions, from an external equipment in
the system; and

5 (d) a control section for selecting the programs for basic
functions by a command from the connection section to accomplish
the basic functions in accordance with the programs selected.

14. A pocket-size hermetically sealed electronic device as
10 claimed in Claim 13, wherein the plurality kinds of basic
functions include a read/write function of data from the second
memory section, an encryption/decryption function for preventing
leakage and falsification of communication data, and a password
setting/password collation function.

15

15. A pocket-size hermetically sealed electronic device as
claimed in Claim 13, wherein said pocket-size hermetically
sealed electronic device comprises an IC card.

20 16. A pocket-size hermetically sealed electronic device as
claimed in Claim 13, wherein the first memory section comprises
a mask ROM.

17. A pocket-size hermetically sealed electronic device as
25 claimed in Claim 13, wherein the second memory section comprises
a PROM and said control section comprises a CPU.

18. A pocket-size hermetically sealed electronic device as
claimed in Claim 13, wherein the external equipment comprises a
30 keyboard, a memory unit, an IC card reader/writer, and a CPU
which reads the data processing programs memorized in the memory
unit in response to the command which is sent via the keyboard,
to select and combine the function codes to supply the result to
the IC card reader/writer, and also executes prescribed
35 processings by receiving a response signal of the IC card from
the IC card reader/writer.

- 1 19. A pocket-size hermetically sealed electronic device as
claimed in Claim 18, wherein the IC card reader/writer comprises
a transportation mechanism for transporting the IC card inserted
to a insertion port to a prescribed position, an IC card contact
5 section which is to be electrical-connected with the connection
section of the IC card that is set at the prescribed position, an
I/O interface for carrying out transfer of command from/to the
CPU of said external equipment, and a control circuit for
controlling the transportation mechanism and the I/O interface.
10
20. A pocket-size hermetically sealed electronic device as
claimed in Claim 13, wherein the command supplied by the
external equipment comprises a function code and a data.
- 15 21. A pocket-size hermetically sealed electronic device as
claimed in Claim 13, wherein said second memory section is
divided into a plurality of zones assigned separately with
different access conditions.
- 20 22. A pocket-size hermetically sealed electronic device as
claimed in Claim 14, wherein said second memory section is
divided into a zone from which read alone is possible, a zone for
which write alone is possible, a zone for which both of read and
write are possible, a zone for which both of read and write are
25 not possible, and a zone for which read and write are possible
only after completion of the password collation, with respect to
the external equipment.

30

35

FIG. 1

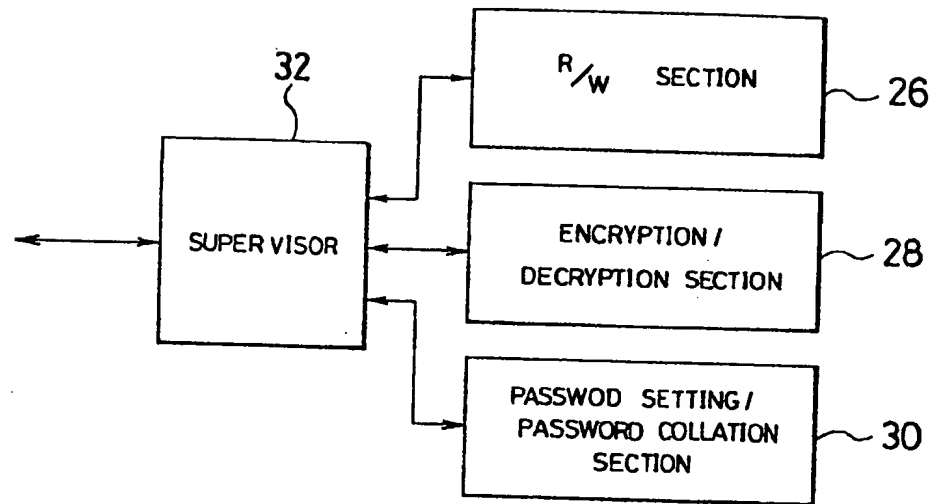


FIG. 2

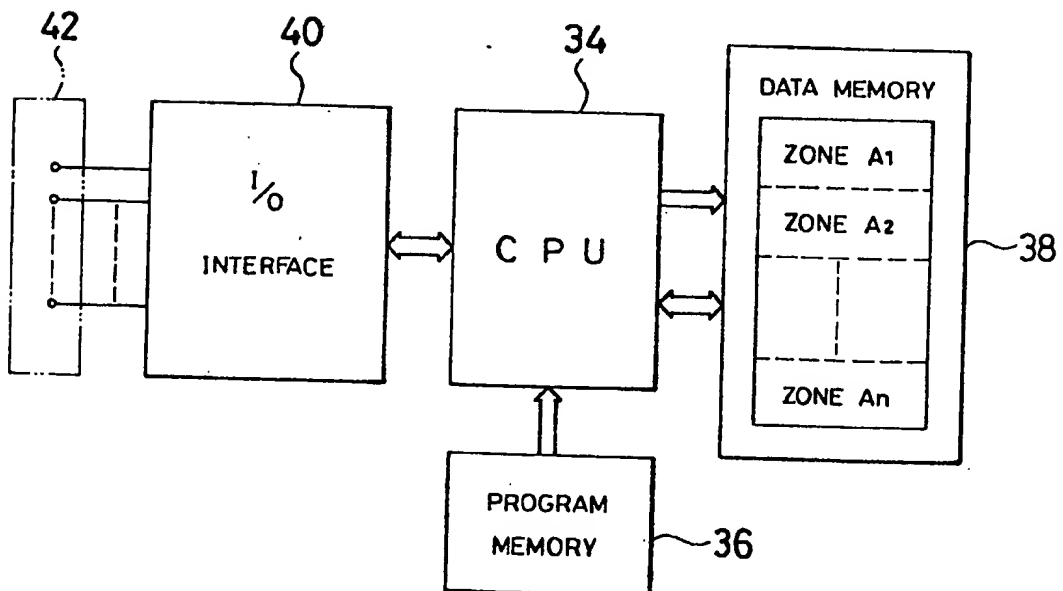


FIG. 3

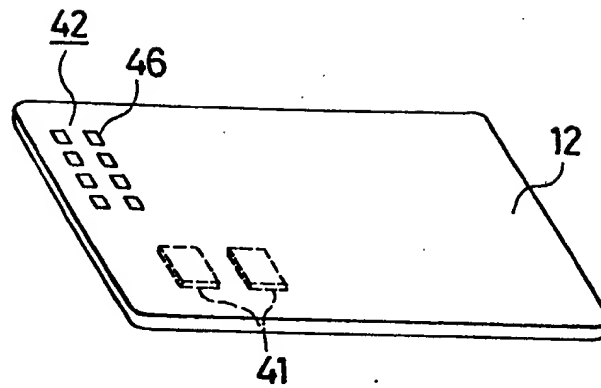


FIG. 4

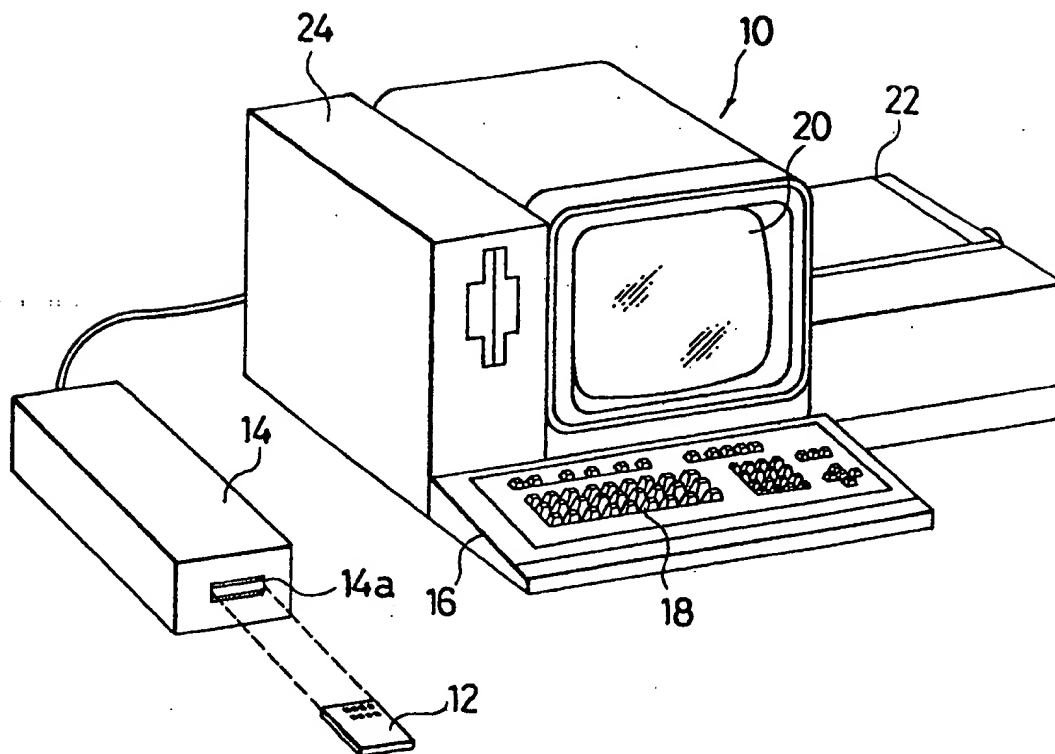


FIG. 5

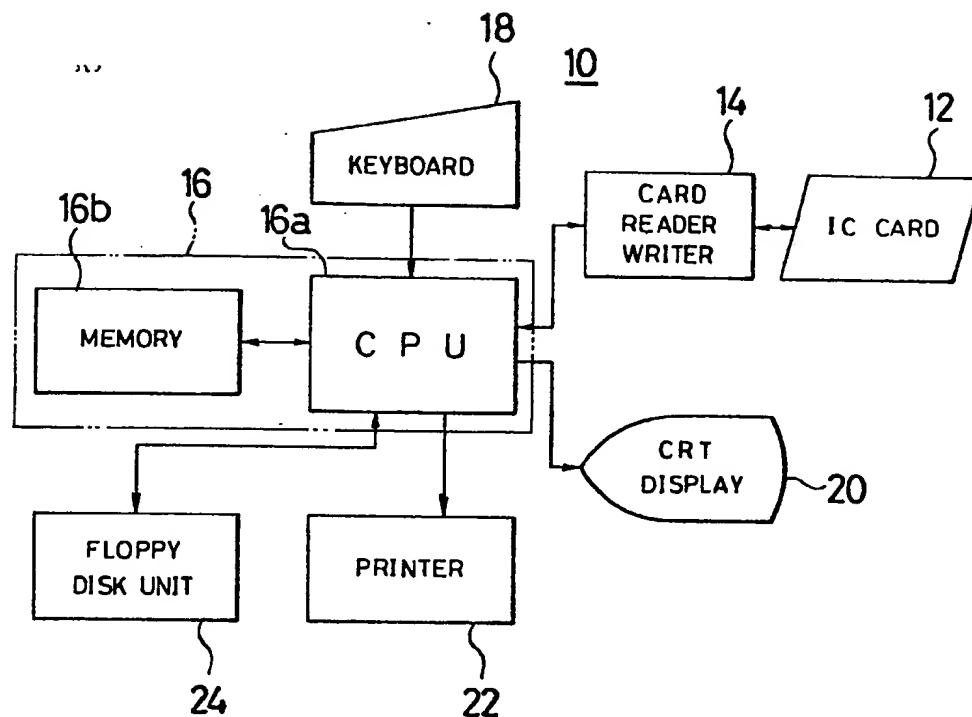


FIG. 6

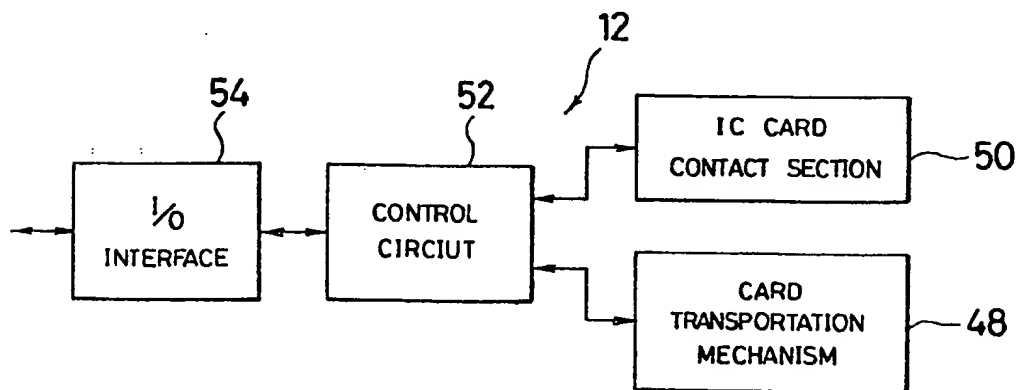


FIG. 7

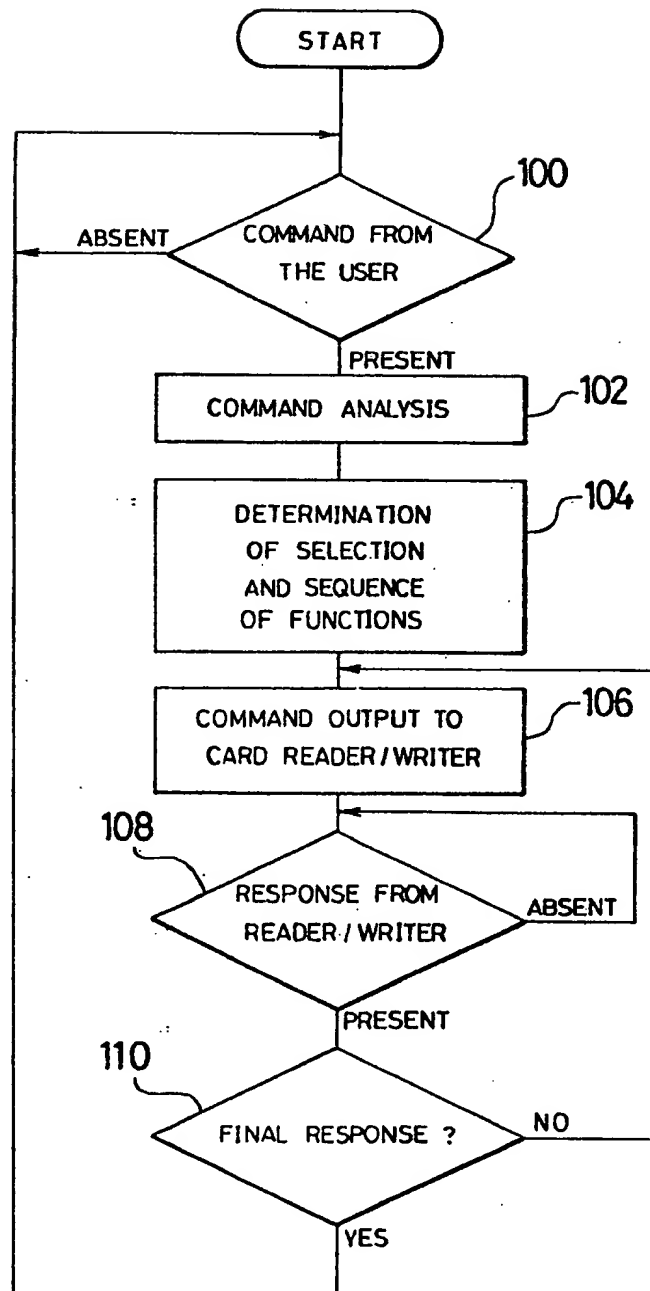


FIG. 8

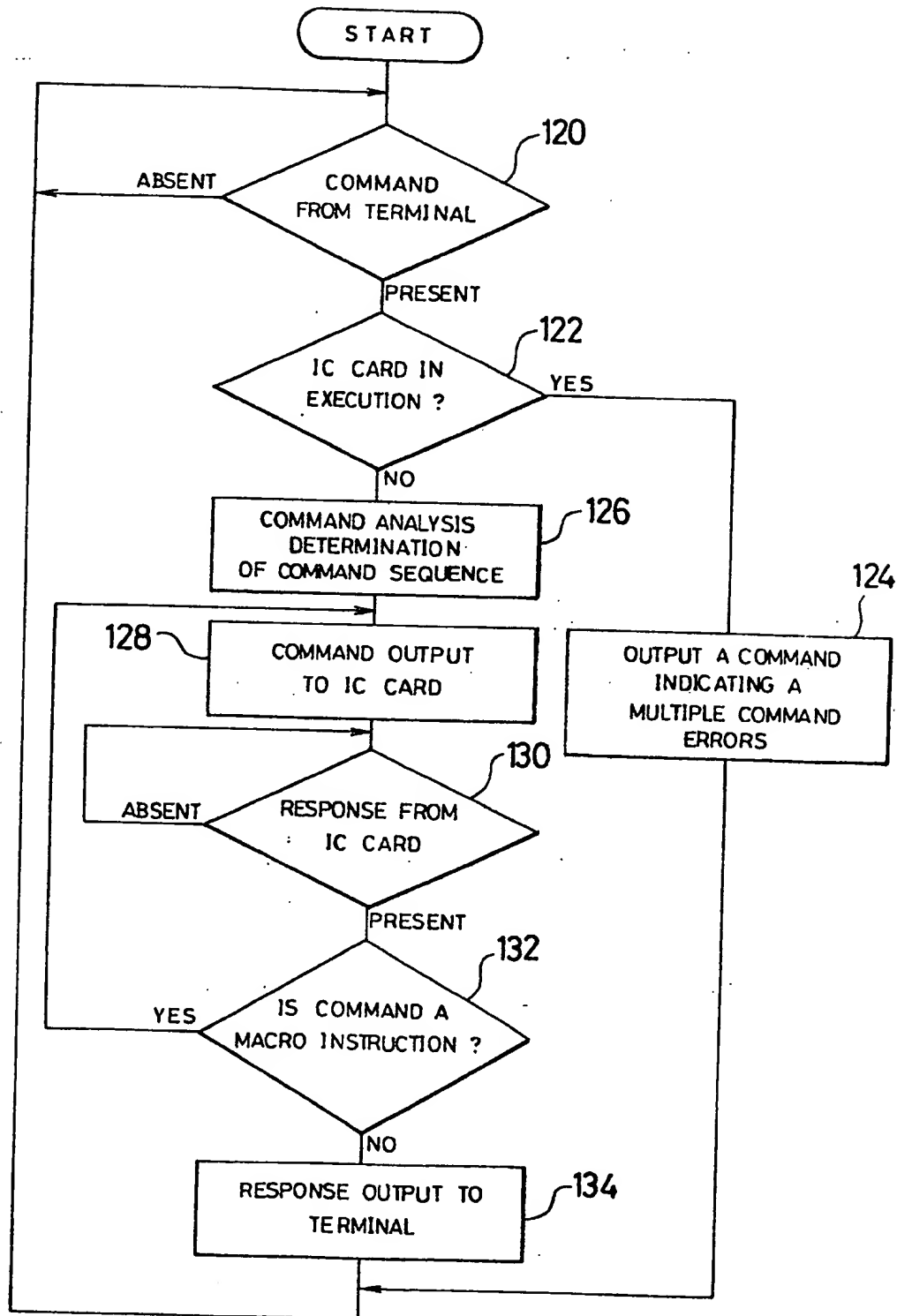


FIG. 9 a

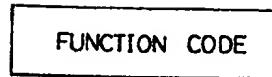


FIG. 9 b

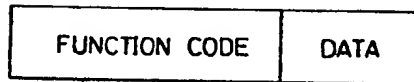
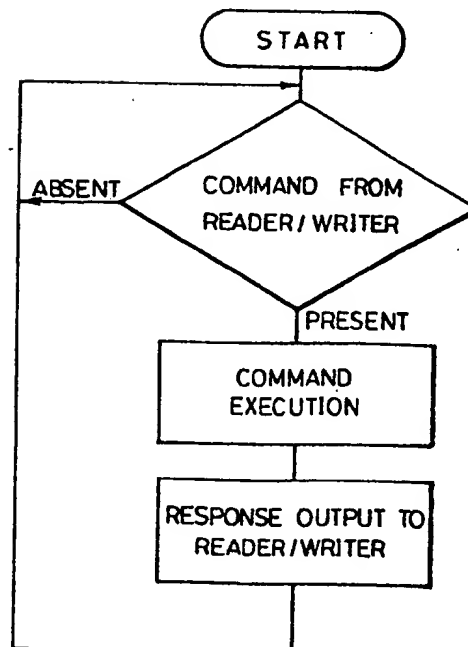


FIG. 10




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sequenceDiagram
    participant USER
    participant TERMINAL
    participant CARD_READER_WRITER as CARD READER/WRITER
    participant IC_CARD as IC CARD

    USER->>TERMINAL: REQUEST FOR PASSNUMBER
    TERMINAL->>CARD_READER_WRITER: INSERTION SIGNAL
    CARD_READER_WRITER->>IC_CARD: CARD INSERTION
    IC_CARD->>CARD_READER_WRITER: PASSWORD COLLATION INSTRUCTION
    CARD_READER_WRITER->>TERMINAL: PASSWORD COLLATION INSTRUCTION
    TERMINAL->>USER: INPUT PASSNUMBER
    USER->>TERMINAL: REQUEST FOR INPUT OF SUM OF PURCHASE
    TERMINAL->>CARD_READER_WRITER: RESULT OF COLLATION
    CARD_READER_WRITER->>IC_CARD: RESULT OF COLLATION
    IC_CARD->>CARD_READER_WRITER: REQUEST FOR LIST (MACRO INSTRUCTION)
    CARD_READER_WRITER->>TERMINAL: REQUEST FOR LIST (MACRO INSTRUCTION)
    TERMINAL->>USER: INPUT SUM OF PURCHASE
    USER->>TERMINAL: REQUEST FOR LIST (MACRO INSTRUCTION)
    TERMINAL->>CARD_READER_WRITER: READ INSTRUCTION
    CARD_READER_WRITER->>IC_CARD: READ INSTRUCTION
    IC_CARD->>CARD_READER_WRITER: DATA
    CARD_READER_WRITER->>TERMINAL: DATA
    TERMINAL->>USER: READ INSTRUCTION
    USER->>TERMINAL: READ INSTRUCTION
    TERMINAL->>CARD_READER_WRITER: FINAL DATA
    CARD_READER_WRITER->>IC_CARD: FINAL DATA
    IC_CARD->>CARD_READER_WRITER: OUTPUT LIST
    CARD_READER_WRITER->>TERMINAL: OUTPUT LIST
    TERMINAL->>USER: OUTPUT LIST
    USER->>TERMINAL: WRITE PURCHASE SUM (MACRO INSTRUCTION)
    TERMINAL->>CARD_READER_WRITER: WRITE PURCHASE SUM (MACRO INSTRUCTION)
    CARD_READER_WRITER->>IC_CARD: WRITE INSTRUCTION
    IC_CARD->>CARD_READER_WRITER: REQUEST FOR INPUT
    CARD_READER_WRITER->>TERMINAL: REQUEST FOR INPUT
    TERMINAL->>USER: REQUEST FOR INPUT
    USER->>TERMINAL: REQUEST FOR INPUT
    TERMINAL->>CARD_READER_WRITER: WRITE INSTRUCTION
    CARD_READER_WRITER->>IC_CARD: WRITE INSTRUCTION
    IC_CARD->>CARD_READER_WRITER: COMPLETION OF INPUT
    CARD_READER_WRITER->>TERMINAL: COMPLETION OF INPUT
    TERMINAL->>USER: COMPLETION OF INPUT
    USER->>TERMINAL: DISPLAY BALANCE COMPLETION MESSAGE
    
```

FIG.12

